WHAT IS CLAIMED IS:

1. A positive active material composition for a lithium-sulfur battery comprising:

a positive active material comprising a sulfur-based compound;

a conductive agent;

an organic mixing solvent in which solubility of sulfur is equals to or less than 50mM; and

a binder comprising at least one polymer dissolvable in the organic mixing solvent.

2. The positive active material composition of claim 1, wherein the polymer is at leas t one selected from the group consisting of polyvinylidene fluoride, polyvinyl acetate and polyvinyl pyrrolidone.

3. The positive active material composition of claim 1, wherein the organic mixing solvent is selected from the group consisting of dimethylformamide, isopropyl alcohol and acetonitrile.

4. The positive active material composition of claim 1, wherein the binder further comprises at least oxide polymer selected from the group consisting of polyethylene oxide and polypropylene oxide.

5. The positive active material composition of claim 1, wherein :

the at least one polymer selected is at least one first polymer selected from the group consisting of polyvinylidene fluoride, polyvinyl acetate and polyvinyl pyrrolidone;

the organic mixing solvent is a first organic mixing solvent which dissolves the first polymer and selected from the group consisting of dimethylformamide, isopropyl alcohol and acetonitrile;

the positive active material composition further comprises:

at least one oxide polymer selected from the group consisting of polyethylene oxide and polypropylene oxide; and

a second organic mixing solvent which dissolves the oxide polymer and is selected from the group consisting of 1,3-dioxolane and acetonitrile.

6. The positive active material composition of claim 1, wherein the binder is polyvinylidene fluoride, and the organic mixing solvent is dimethyl formamide.

7. The positive active material composition of claim 1, wherein the binder is polyvinyl pyrrolidone and the organic mixing solvent is isopropyl alcohol.

8. The positive active material composition of claim 1, wherein the binder is polyvinylacetate and the organic mixing solvent is acetonitrile.

9. The positive active material composition of claim 1, wherein the sulfur-based compound is at least one compound selected from the group consisting of elemental (S_8), solid Li_2S_n ($n \geq 1$), an organic-sulfur compound and a carbon sulfur polymer [$(C_2S_x.)_n$, x=2.5 to 50, n2].

10. The positive active material composition of claim 1, wherein the positive active material composition comprises 5 to 30 percent by weight of the binder.

11. The positive active material composition of claim 1, wherein the organic mixing solvent has a solubility of sulfur of 1 to 50mM.

12. The positive active material composition of claim 2, wherein the polymer is at least two selected from the group consisting of polyvinylidene fluoride, polyvinyl acetate and polyvinyl pyrrolidone.

13. The positive active material composition of claim 5, wherein a mixing ratio between the binder and the at least one oxide polymer is 1 to 9:9 to 1 in weight ratio.

14. The positive active material composition of claim 1, wherein the conductive agent is a at least one conductive carbon material selected from the group consisting of graphite, carbon black, polyaniline, polythiopene, and polypyrrol.

15. A lithium-sulfur battery comprising:

a positive electrode comprising a positive active material including a sulfur-based compound, a binder and a conductive agent, the binder comprising at least one polymer which dissolves in an organic mixing solvent, the organic mixing solvent having a solubility of sulfur of equal to or less than 50mM;

a negative electrode comprising a negative active material, the negative active material being selected from the group consisting of materials in which lithium intercalation reversibly occurs, materials which react with lithium to form a lithium compound, a lithium metal and a lithium alloy; and

an electrolyte comprising a lithium salt and an electrolyte-organic solvent.

16. The lithium-sulfur battery of claim 15, wherein the polymer is at lease one selected from the group consisting of polyvinylidene fluoride, polyvinyl acetate and polyvinyl pyrrolidone.

17. The lithium-sulfur battery of claim 15, wherein the binder further comprises at least oxide polymer selected from the group consisting of polyethylene oxide and polypropylene oxide.

18. The lithium-sulfur battery of claim 15, wherein the sulfur compound is at least one compound selected from the group consisting of elemental (S_8), solid Li_2S_n ($n \geq 1$), an organosulfur compound and a carbon sulfur polymer [$(C_2S_x.)_n$, x=2.5 to 50, n2].

19. The lithium-sulfur of claim 15, wherein the electrolyte-organic solvent is selected from the group consisting of benzene, fluorobenzene, toluene, trifluorotoluene, xylene, cyclehexane, tetrahydrofuran, 2-methyl tetrahydrofuran, cyclohexanone, ethanol, isopropyl alcohol, dimethyl carbonate, ethylmethyl carbonate, diethyl carbonate, methylpropyl carbonate, methyl propionate, ethyl propionate, methyl acetate, ethyl acetate, propyl acetate, dimethoxy ethane, 1,3-dioxolane, diglyme, tetraglyme, ethylene carbonate, propylene carbonate, γ-butyrolactone and sulfolane.

20. The lithium-sulfur battery of claim 15, wherein the lithium salt is at least one compound selected from the group consisting of lithium hexafluorophosphate ($LiPF_6$), lithium tetrafluoroborate ($LiBF_4$), lithium hexafluoroarsenate ($LiAsF_6$), lithium perchlorate ($LiClO_4$), lithium trifluoromethanesulfonate (CF_3SO_3Li) and lithium bis(trifluoromethyl) sulfoneimide($LiN(SO_2CF_3)_2$).

21. The lithium-sulfur battery of claim 15, wherein the electrolyte comprises a concentration of 0.5 to 2.0M of the lithium salt.

22. The lithium-sulfur battery of claim 11, wherein the organic mixing solvent has a solubility of sulfur of 1 to 50mM.

23. The lithium-sulfur battery of claim 12, wherein the polymer is at least two selected from the group consisting of polyvinylidene fluoride, polyvinyl acetate and polyvinyl pyrrolidone.

24. A positive active material composition for a lithium-sulfur battery comprising:

a positive active material comprising a sulfur-based compound;

a conductive agent;

an organic mixing solvent being selected from the group consisting of dimethyl formamide, isopropyl alcohol and acetonitrile; and

a binder comprising at least one polymer being selected from the group consisting of polyvinylidene fluoride, polyvinyl acetate and polyvinyl pyrrolidone.

25. The positive active material composition of claim 24, wherein the binder further comprises at least oxide polymer selected from the group consisting of polyethylene oxide and polypropylene oxide, and the organic solvent further comprises 1,3-dioxolane.

26. The positive active material composition of claim 24, wherein the positive active material composition comprises 5 to 30 percent by weight of the binder.

27. A positive active material composition for a lithium-sulfur battery comprising:

a positive active material comprising a sulfur-based compound;

a conductive agent;

an organic mixing solvent; and

a binder comprising at least one polymer which becomes ionic conductive when wetted by a liquid or gel electrolyte.

28. A method of preparing a positive electrode for a lithium-sulfur battery comprising:

dissolving a binder comprising at least one polymer in an organic mixing solvent in which solubility of sulfur equals to or less than 50mM, to obtain a first mixture;

dispersing a conductive agent into the first mixture to obtain a dispersion solution;

homogeneously dispersing a positive active material comprising a sulfur-based compound in the dispersion solution, to prepare a positive electrode composition; and

coating the positive electrode composition to a current collector and drying the coated current collector.

29. The method of claim 28, wherein the polymer is at lease one selected from the group consisting of polyvinylidene fluoride, polyvinyl acetate and polyvinyl pyrrolidone.

30. The method of claim 28, wherein the organic mixing solvent is selected from the group consisting of dimethylformamide, isopropyl alcohol and acetonitrile.

31. The method of claim 28, wherein the binder further comprises at least oxide polymer selected from the group consisting of polyethylene oxide and polypropylene oxide.

32. A method of preparing a positive electrode for a lithium-sulfur battery comprising:

dissolving a binder comprising at least one polymer selected from the group consisting of polyvinylidene fluoride, polyvinyl acetate and polyvinyl pyrrolidone in an organic mixing solvent selected from the group consisting of dimethyl formamide, isopropyl alcohol and acetonitrile, to obtain a first mixture;

dispersing a conductive agent into the first mixture to obtain a dispersion solution;

homogeneously dispersing a positive active material comprising a sulfur-based compound in the dispersion solution, to prepare a positive electrode composition; and

coating the positive electrode composition to a current collector and drying the coated current collector.

33. The method of claim 32, wherein the polymer is at lease one selected from the group consisting of polyvinylidene fluoride, polyvinyl acetate and polyvinyl pyrrolidone.

34. The method of claim 32, wherein the organic mixing solvent is selected from the group consisting of dimethylformamide, isopropyl alcohol and acetonitrile.

35. The method of claim 32, wherein the binder further comprises at least oxide polymer selected from the group consisting of polyethylene oxide and polypropylene oxide.